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ABSTRACT

The keynote address from the proceedings of the 1988 Conference on Academic Talent is presented here. The address criticizes the current educational system for its concentration on college preparatory courses that have little or no hands-on experience. It argues that the existing system does not encourage curiosity, a problem seen as so pervasive that it needs to be examined from a vertical integration or systems engineering point of view. Increasing interest in the area of science and technology education has recently been evidenced by several professional groups, which may lead to such an examination. Reactions of two discussants are appended. Frances Degen Horowitz highlights the need for a national policy which commits sufficient resources to develop the talents of children, and a policy which overrides some local, community control issues. William Anlyan notes the importance of looking to the free enterprise system in addition to government for help with the problem of developing academic talent, comments on the growing laziness of the United States as a nation, and supports the recognition of nontraditional forms of talent. (JDD)

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DEVELOPING ACADEMIC TALENT: A PROBLEM OF VERTICAL INTEGRATION

Alvin W. Trivelpiece

I know that most of you had your material prepared and written some time ago. I did not. Between regular responsibilities, the nightmare of remodeling an apartment, and arranging an event with the President on this Wednesday, I got a little behind.

So yesterday, as I was beginning to prepare what I might say here today, I realized: first, that since it was Sunday and I wasn't out jogging, I had taken on too many commitments; second, that education is still a very personal matter even though it is highly institutionalized; and third, that science and technology education is being discovered by everyone. Yes, folks, everyone. Even the physicians have come to the conclusion that there is a problem with science and technology education. They want to help. On the personal aspects I am going to draw on some of my own experiences. It may be a little bit different from the points you normally hear, and if they raise some discussion and controversy, so much the better.

Stockton, California, where I was born in the 1930's was not what I would refer to as a hot bed of scientific research where contact with scientists or engineers of any kind was possible. There were no role models, no enrichment programs, nothing. But, there were batteries, switches, pieces of wire, ignition coils from Model T-Fords, old radio sets, my grandfather's saw filing shop, Model-A Fords to take apart, shop courses beginning in the fifth or sixth grade where it was possible to learn to solder, operate a lathe, make a breadboard, and so on. In short, as far back as I can remember, there was a virtually limitless supply of things to take apart, build, repair, modify, improve, etc. As it turned out, I went on to pursue a career in experimental and theoretical physics.

Surprisingly, the things that were to prove to be most valuable to me were not the courses in algebra, geometry, trigonometry (which I had to take as a correspondence course), or chemistry (which wasn't available) or physics (which was), but rather they were the shop and vocational training courses. Now I know that to some in the education business this is heresy, but in my case it is true. What I regard as the most important feature of why I became a Physicist was that I was curious (perhaps inquisitive is a better term since some believe I still am a bit curious) and that there were countless objects on which I could inflict my curiosity. Most of these objects never worked again, but I learned how they worked, and more important, I learned how to figure out how they worked. The shop courses gave me the skills to design and make much of the complex apparatus of advanced experimental physics research. In my own research in Plasma Physics, I used this practical knowledge as much and maybe even more than my knowledge of Newton's Laws, Maxwell's Equations, and Quantum Mechanics.

As a professor of Physics, I used to be appalled at what I called the kinesthetic illiteracy of some of the graduate students who did their advanced degree work under my supervision. Some of them didn't know which end of a soldering iron to pick up. How can you be an effective scientist with such a disability? I know that some of the contemporary thinking in educational circles has it that you can learn these things quickly once you have the theoretical principles well in mind. Maybe so. But I question this conclusion and, besides,

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where do you learn curiosity? How is it taught? I claim that the only time in your life that you are ever a true intellectual is when you can afford to ask a question without giving any serious concern as to whether the answer is important to you in your ability to make more money or pass a course. When is that time? Every parent knows. It is when they are subjected to that endless sequence of "why" questions. Why is the sky blue? Will I run out of words? How many words do I have in me? I'm sure that you know hundreds of such questions.

My question is: What happens to that curiosity after a few years in elementary school? Does it decay in some of us naturally? Is it brutally beaten out of us by a system that seeks to impose social conformity on us? I am sure that I don't know, and I suspect that there is no good or simple answer.

In the case of my own children, who had the good fortune to go to otherwise excellent elementary and secondary schools near Washington, DC, I was appalled to learn that there were no shop courses for them in their schools, and worse, our nice new suburban home lacked a generation of junk to take apart. It's not, that there were not the kind of courses that I took, which made it possible to become a Journeyman Electrician the year after I was out of high school, but it was much worse. There were no lathes, no shapers, no soldering irons; nothing to speak of. As a result, I did things to compensate for this oversight of the School Board. I built a shop in my basement for Electronics, Chemistry, Woodworking, and general messing around. I did this so that my children would not be as disadvantaged as some of the students that I saw in the University in terms of simple technical skills and basic curiosity. In addition, I took two of my three sons over to the student shop at the University of Maryland on Saturdays and had them do projects that allowed them to gain experience in the use of most standard shop tools. This was the naural time for them to learn these skills and they weren't big on regular school courses anyway. They both ended up getting degrees in Physics, and now have their own computer hardware and software company out in California. No they didn't go on to get advanced degrees and pursue academic careers. Was I disappointed? Yes, slightly. But their choice was driven more by their economics goals rather than by any lack of curiosity.

What is the point here? To brag about the fact that my kids made it through college. No. Although it was nice to get them off the family dole. I believe the point here is that, as a result of our collective effort to stress academic achievement and a concentration on college preparatory courses that have little or no hands-on experience that involves building things or taking them apart to see how they run, we may have created conditions where learning has become just a tad boring. Curiosity is certainly not encouraged by the present system and is maybe even being stifled by excessive attention to "book learning" to the exclusion of developing some technical skills. I look around today and I ask, "where are the equivalent kind of things that were available to me in school and around the places where I lived?" I don't find them.

I believe that, even with my efforts to compensate for the lack of certain experiences for my own children, they had a deprived childhood compared to my own in terms of things to play with. Have you taken an alarm clock apart lately? What did you find? Gears, knobs and springs? No. You found a microchip, some leads, and a battery. Try to learn something from that other than not to do it

again. Try to figure out the ignition system in your car. Again a computer with some microchips. Your compact disc player is the same way. Take your camera apart and you'll find a computer. And worse, in order to take a frog apart in some places you have to use a computer instead of a frog.

To be sure, education is learning, discipline, social training, and exposure to many different subjects, but I believe it should also be fun in a way that encourages certain aspects of that natural curiosity that young children have. Can we do this? Who knows? Should we try? I believe that we should. Why? Because if we lose them at the age of 3 or 4 or 5, it is just as serious as if we lose them in the seventh or eleventh grades. I may be wrong, but I don't believe that it is possible to recapture the natural curiosity of children in a way that is going to get them back into the flow in high school in the numbers needed by our universities as the raw material for training or as future scientists, engineers, or faculty members. So I believe that efforts to encourage students to pursue careers in science and technology in the 8th or 9th grades are important and shouldn't be minimized, but if they didn't get them on the curiosity bandwagon earlier, forget it.

The Navy is concerned that in a few years the level of education of high school graduates is going to be inadequate to operate our current modern high tech ships, planes and submarines, let alone the future. Industry also has a great stake in this matter. The factory of today is already quite complex technically and the factory of tomorrow will be even more so. Where will the needed work force come from?

The fact that this problem is so pervasive is why I believe that we need to look at the entire system and examine it from a vertical integration or a systems engineering point of view. The Universities complain that the high schools don't prepare the kids for physics or whatever you like. I used to sing that chorus. The high schools in turn complain about the job the elementary schools do. This puts the blame on the kindergarten teacher or pre-school teacher, and so on down the line; or as Shirley Malcolm explains it, the grandmother tells her daughter, "Don't blame me for the way your kid is turning out. I told you that bum you were dating had bad genes!"

It's all well and good for us to yell at each other up and down the system, but it doesn't solve the problem. Furthermore, the system is dynamic in ways that need to be understood better if we are to avoid certain classic mistakes. For instance, in the late 60's there was a softening of the job market for scientists and engineers. As a result, a few of them who couldn't get jobs wrote the President and complained. The President fixed the problem by cutting off fellowships for students in technical disciplines. What an exquisite sense of timing he had. This was the time when the supply should have been kept up because there was going to be a shortage later. It was made worse because of the feedback effect which amplified the problem. The system was unstable, that is, the gain was greater than one and the phase shift was 180 degrees. Can you imagine certain industries in the U. S. and overseas relying on vendors to supply goods or services that are vital to their interests and survival without at least attempting to achieve some degree of vertical integration or without understanding the dynamics of flow of materials needed to meet their production requirements?

It seems to me that we go out of our way to avoid understanding these dynamics in education.

It was with these and related matters in mind that the reconstituted *Working Group One* of the Government University, Industry Research Roundtable (GUIRR) began planning to consider this problem from what might be called a systems point of view or one of vertical integration. I know that most of you are familiar with GUIRR, but let me go over some features that it has that might give it an advantage in working on this problem of providing suitable talent for our nation. First of all, GUIRR is unique in that officials from Government can sit down and discuss matters of interest with representatives from Universities and Industry without a priority violating the Federal Advisory Committee Act. Second, GUIRR has no direct ability to do anything. "So why bother to try?". you might ask. Look at the so-called "Florida Experiment" in which some real progress in reducing bureaucratic accretion has been made. This has been accomplished in part by getting the Feds the use of the same boiler plate for all grants and contracts with all of Florida's Universities with the understanding that there will be a corresponding reduction of non-essential reviews by the State and the Universities themselves. One of the reasons this is working is that those who have to live with the changes are implementing them. The experiment is by no means over and its extension to their political subdivisions remains to be accomplished, but even the most cynical among us (by that I mean the OMB) seem to believe that it has good prospects.

Can GUIRR play a similar, useful role in this question of the supply of academic talent, particularly in the areas of science and technology? That is not clear. However, what is clear is that GUIR doesn't have the same vested interest in looking at the problem as some of the other players in the game (i.e. primary, secondary, unions, etc.). What we have done so far has been limited to some organizational meetings to see where we might go with the idea trying to look at the talent problem. We certainly would welcome suggestions.

Lately it seems that everybody is either worrying about or working on some aspect of the education problem. Most of what I have seen involves the question of science and technology education, but I know that the problem is quite pervasive across the board. I don't pretend to be an expert in this subject area, but it seems to me that something useful has gone out of our lives with the almost universal elimination of shop courses or their equivalent along with the inability to take things apart that our modern microchip world has brought us. Now I don't inhabit places like "TOYS R US" as much as I used to when my children were little and maybe my perception is wrong, but I don't see this lack of things to take apart being replaced by toys that might accomplish the same purpose. Namely, in generating a curiosity about the world and how it works, thus stimulating a natural desire to keep going in studies in areas where the going eventually does get a little tough. Maybe there is a market for producing already broken, spring-driven, mechanical alarm clocks.

In closing, I want to point out that in the last few weeks I have attended several meetings on science and technology education. Not surprising, you say, and even overdue. Particularly since every candidate seems to want to be known as the Education President. Actually, what I found surprising was that I believe

that I was the only individual invited to all of these separate meetings. To the best of my recollection there was no other overlap. These meetings included one by *USA Today* and ALCOA to discuss their Scope Program and a meeting by the Council on Competitiveness, which plans a paper on this subject for the transition team after the election and some missionary work on the platform content regarding education.

Perhaps the most surprising and most interesting meeting was the one organized by the AMA. As a result of their meeting, there is now a modest effort to explore the possibility of a National Congress on Science and Technology Education in America next March or April in Washington with literally a cast of thousands, including the President as keynote speaker. Will it happen? Who knows, but the AMA is an effective organization once it gets moving and committed. They already have a draft charter for this Congress and a working group to look into the next steps. If you are interested in helping it along, or killing it before it gets going, you might call Bill Hendie at the AMA in Chicago.

I am pleased that there seems to be so much attention to this problem of improved educational conditions for our children. There is no single or simple solution to the problems that we face. But there is a sea of change that gives me hope that improvements can be made. Namely, there is now an element of market pull rather than push in that the consumers of the product of our schools--the doctors, the services, industry--recognize that they are facing a critical supply problem. So I say welcome to the AMA. Maybe the dentists will even get involved. When that happens the problem will be solved quickly--the kids will be told, "Learn science or I will drill your teeth!"

Discussant Reaction:
Developing Academic Talent: A Problem of Vertical Integration

Frances Degen Horowitz

They say that those who do not know history are condemned to repeat it. I am reminded that the last time we seriously talked as a nation about science and math was in the 1950's after the Russians launched Sputnik. The Sputnik event then spawned a whole array of programs in this country that had a considerable impact. The sobering questions we need to ask ourselves are: 1) Why they didn't survive, and 2) Why we're talking about the math and science question again.

Some of you may know a book called *Children of the Dream* written by a psychoanalyst named Bruno Bettleheim of the University of Chicago. When Chicago was torn by riots in the 1960's he decided that one of the models that he wanted to investigate as a possible solutions for Chicago's concern for its children was the kibbutz in Israel. He went to Israel and stayed six weeks and wrote *Children of the Dream*. It was a very controversial book in Israel, but it is a very interesting book. Actually, although he spent only six weeks there, he did capture much of the essence of the kibbutz. But he ultimately came to the realization that the proportion of resources that the kibbutz spent on its children was so far out of line in proportion to the resources that Chicago--or any city in the United States--was prepared to spend on its children, that the kibbutz model of educating its children was not a viable model. That is a very telling conclusion.

I believe that a society is ultimately judged by the commitment of its resources to care for its children and its old people. In the United States we don't fare very well by that measure. Our policies with respect to education in this country are analogous to planting young seedlings and periodically pulling them up by their roots to see how they are doing. One doesn't get a fullsome forest in this way, and our policies with respect to caring about children in this country are mired in conflicting values.

I teach a course at the University of Kansas on developmental theories. At the beginning of that course I give an overview of the history of developmental psychology. One of the stories that I like to tell is the story of the establishment of the Iowa Child Welfare Research Station. It then changed its name to the Institute of Child Behavior and Development but was still known as the Iowa Child Welfare Research Station. It got its name in an interesting way and was established in an interesting way. Just before World War I an Iowa woman named Cora Bussey Hillis conceived of the notion of having a station like an agricultural research station where parents could go and get help raising their children the way farmers went and got help raising their crops. She went to the University of Iowa and she proposed to endow a child welfare research station. The president of the University of Iowa was aghast at the idea because children and universities didn't seem to him to mix very well. He suggested that she might give her money for a bell instead, that would ring out across the campus. Well, this was a very persistent lady, and she went to the legislature and proposed to the governor that the State of Iowa establish a child welfare research station. The transcripts of the debate in the Iowa legislature in those years are very interesting. The issues raised were as follows: What business did the government have intruding in family life? Children are the responsibility of parents, and the State should not be involved in raising children. If this sounds familiar, it could possibly be because

we haven't changed all that much. She proposed it and she was turned down, but in 1919 the Iowa Child Welfare Research Station opened.

In 1919 as a result of the United States entering the First World War, the first wholesale evaluation of young men of this country revealed a large number of young men who were physically and mentally unfit to serve in the Armed Forces of the United States. Cora Hillis was able to use that information to say "See, it is the business of the government, it is the business of the nation to care about its children".

We're still arguing today about the intrusion of the government into the family, about what kinds of responsibilities we have toward child care, and about what kinds of meaningful national policies we ought to establish with respect to children and education. Al Trivelpiece asked the question 'When do we lose children?' We lose children when we don't have enough resources, when we don't have enough commitment as a nation to commit resources to care about children, and when we don't have enough commitment to believe that children can learn.

I'm a developmental psychologist. We know a lot about cognitive development, early development, and the kinds of talents that children have that never come to fruition. More talents are lost than are developed in this nation, and that's not something of which we should be proud. What are the dynamics of this?

Al talked about vertical integration. We don't have any vertical integration in education or in educational policy in the United States. We have traditions of local control, of community control of schools, community control of curriculum. These are strong American traditions. In Kansas there has been an argument about qualifications for university enrollment. Kansas is a Populist state by virtue of old traditions. Any student in Kansas who graduates from a Kansas high school has a right to go to one of the state institutions. The University of Kansas, like other universities around the country, is dismayed at the lack of preparation in mathematics, in science, and in foreign languages at the high school level. The Board of Regents proposed a mandatory curriculum in the high schools as a condition for admissions to the State Universities. This would require a modification of the admissions law of Kansas. The proposal was not approved by the legislature. Part of the issue was the willingness of the communities, many of which are small communities, to commit resources to an educational curriculum to include all the necessary courses. Part of the issue was local control over the schools but part of the issue was resources.

This highlights the kind of problems that we face as a nation when we want to take a global, national view about the development of a pool of science talent. We have many programs around the country that foster different kinds of talent. If we, as a nation, actually decided to apply the knowledge that we have gained from the existing programs, we could make major advances in the number of children we could nurture in their talents in science and mathematics. The question is, can we seize the moment now in a better way than we did in the 1950s. Japan has recently become the ideal model. But is Japan really the model for this country? Japan is a more homogeneous nation and it has a very different cultural tradition. The effort to superimpose Japan on the U.S., I believe, is ultimately going to fail, because we cannot take models that are not relevant to

our culture, to our traditions, and make them succeed. What we can learn from Japan is to commit our resources to care about the children in order to accomplish things.

The issue for us comes down to whether we are willing to make that kind of commitment and whether we are willing as a nation to say that some things have a national importance that will override some of the local, community control issues. This is a very threatening kind of question to raise, particularly in small communities and in small states. The papers that we are going to hear at this conference are going to raise some very important issues with respect to demographics, with respect to population, with respect to committing resources. While the topic of this conference is primarily aimed at science and math, the challenge is a larger one. It is a matter of committing ourselves to and nurturing the talent of all the children in the nation. If we succeed in that, then the science and math challenge will have been solved. So, it's a much more basic question: Those of us who are concerned about what's happening to our children in this country have to raise the issues that address the kind of nurturing we provide and the effect of providing insufficient resources to educate our children.

Discussant Reaction:
Developing Academic Talent: A Problem of Vertical Integration

William Anlyan

Al has covered the waterfront very well. He and I have overlapping roots with the Roundtable group. Let me try to introduce a couple of notions different than those he has already presented.

In most developed and developing countries that I have visited, the government is the sole source of monetary support. I ran into this very firmly at the World Health Organization where they would point out that the Scandinavian countries supported research on parasitic diseases by a multiple factor of ten times the research supported by the US. What people abroad don't appreciate is that the U.S. Government is not the only source of resources in the United States. The impression that everything has to be looked at from the federal government is a mistake. For instance, in parasitic diseases one of the most important sources of support is not in the federal government, but the kind of support that the MacArthur Foundation has made available. This conference cannot look to the federal or state or local governments for solutions. We've got to look at the entire free enterprise system, using foundations and corporations and all the mish-mash that makes up the United States as we look at this problem.

I grew up in the British school system for the first 17 years of my life, in an English Publish school in Alexandria, Egypt. The school was designed to prepare and point students towards Oxford and Cambridge; because of World War II, I ended up at Yale. But there's much to learn from the British public school system in terms of nurturing science and math talent for the future. There's a lot about the structure of the British public school system that can't be stomached by the egalitarian American system, but nevertheless, if we're serious about the nurturing of science and math talent we ought to look at the idea of training some capable people specifically for the university.

The next thing I would like to touch on is what I've run into in contrast with Japan. In Japan people work six days a week. On Sundays, they take their kids to the museums to add to their enrichment. I bring this up because I have the feeling that we've become lazy as a nation; we've become lazier as adults and I hope that this does not spread to our children. If competition with Japan is one of our national goals, in addition to altruism and humanitarianism, we ought to look at what's become of the population of the United States today. I had a big shock when I was making surgical rounds one Thursday afternoon and asked, "Where's the resident Jones today?" "Oh, he's off on a long weekend." I had never heard of residents having long weekends until that point. I'm not saying that we should work a hundred hours a week, but certainly as a nation we have become lazy.

All of the sciences are important in our education system, but the one thing that we've really got to be careful of in the field of medicine is to prepare people who are first rate as scientists and physicians, and who also have a humane touch, communication skills, and consistent day-to-day application of their talents. I don't know how to do this. It can't be done by requiring courses in the humanities in medical school or in preparation for medical school. But it's an area

which we must address because, particularly in biomedicine, it is almost as key a factor as the delivery of scientific medicine.

Al has identified the fact that we've got to look at both the genetic background and the environmental background when we study how to nurture scientific talent. I'm not saying that we're going to have the Nobel Prize winner sperm bank or ovae, but certainly the environment and genetics are both important.

I'd like to stop with one of my wilder thoughts. I saw 15 years ago that we were not going to have enough nurses in the future, and that we ought to be looking at developing some other kinds of health professionals. I made the mistake of touting that line about 15 years ago, and I can assure you that I've got a back full of scars as a result of that. But last fall it began to be popular thing for certain foundation heads to begin to espouse, and I kidded some of them saying where were you 15 years ago when I was out there all alone being shot at. But, I feel that if we had an ideal pilot university, unencumbered by state legislators, the way in which to nurture talent coming into a school would be to take the top twenty-five percent of a class who are geniuses, who had clearly demonstrated ability at the 0.1 percentile of any kind of test we could manufacture. I would also take the bottom 25 percent if they had lousy SATs but they were geniuses in music or art or something very special. These students may not test well across the board but they have great potential to do something extremely well. The middle fifty percent would be made up of students who were good and had come from a traditional environment in order to build the base of the people who, for the most part, are going to run this nation in the future. I think that we pay far too much attention to saying, "Last year our SAT average for the freshman class was 1380. This year we're at 1410." We should just take the top 25 percent on the basis of their SATs but also look for people who are nontraditional, at the bottom end of SAT scores. They may be the top of the future in terms of hidden talents.